ANALYSES

OF

GRAINS AND VEGETABLES,

DISTINGUISHING THE NITROGENOUS FROM THE NON-NITROGENOUS INGREDIENTS,

FOR THE PURPOSE OF ESTIMATING

THEIR SEPARATE VALUES FOR NUTRITION.

ALSO,

ON AMMONIA FOUND IN GLACIERS;

AND ON THE

ACTION AND INGREDIENTS OF MANURES.

By E. N. HORSFORD, A. M.

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VALUE OF DIFFERENT KINDS OF VEGETABLE FOOD,

BASED UPON

THEIR PER CENTAGE OF NITROGEN.

By E. N. HORSFORD, A. M.

READ BEFORE THE ALBANY INSTITUTE, APRIL, 1846.

Since Gay-Lussac's discovery of nitrogen in the seeds of plants, the conception of animal nutrition has been assuming a more and more definite character.

Already had the principal proximate ingredients of meals, by taking advantage of their physical properties, been separated from each other; gluten, albumen and legumin, starch, gum, sugar, dextrine, and woody fibre were known, and their physical, as well as some of their chemical properties * had been studied.

Their more accurate chemical constitution was reserved to a later period, when the interesting disclosure was made, that they may be arranged in two classes, those containing nitrogen, and those containing no nitrogen ; and that the former as well as the latter are, among themselves, nearly identical in composition.

It is well known that laborers, supplied only with food containing no nitrogen, become incapable of executing their

* Fr. Marcet found gluten consisting of 55.7 per cent. of carbon, 22.0 per cent. of oxygen, 7.8 per cent. of hydrogen, and 14.5 per cent. of nitrogen.—*Annal. de Chim. et de Physiq.*, xxxvi. p. 27.

tasks; and further, that the corporeal system, even without labor, cannot be sustained upon such food. The discovery of the near identity in chemical composition between vegetable albumen, fibrin and caseine, and the corresponding bodies found in the animal kingdom, gave the above facts their explanation.

The food must contain an ingredient suited to replace the animal matter consumed.

This being known, and the quantitative relation of the several elements of the nitrogenous compounds being also known, an estimate of the value of given kinds of food, becomes, in the hands of the chemist, a problem of comparatively easy solution.

The following investigation, undertaken at the suggestion, and under the direction of Prof. v. Liebig, in the Giessen Laboratory, had for its object the determination of the *relative values of different kinds of vegetable food.*

These values are threefold.

The various forms of food derived from grains, herbage and roots, furnish, 1st, bodies containing nitrogen, 2d, bodies destitute of nitrogen, and, 3d, inorganic salts, — all of which are serviceable in the animal economy.

The nitrogenous bodies, from their solution in the blood, form the tissues — the actual organism. The bodies wanting nitrogen contribute, by their more or less perfect combustion, to the warmth of the animal body; and the salts of the alkalies and alkaline earths, serve in building up the osseous framework, beside constituting an essential part of every organ of the animal system.

Their values for the latter purpose are in proportion to the phosphates the ashes contain.

Their values for the second purpose above mentioned, may be considered, in general, as in the inverted relation of their values for the first; — since the larger the proportion of nitrogenous bodies, the less must be the proportion of bodies anting nitrogen

Their values for the first purpose, that of ministering to the support and growth of organic tissues, have been the specific object of the hereafter enumerated determinations.

Boussingault, to whom the Agriculturist is so largely indebted for practical researches bearing upon the interests of husbandry, has not left this field untrodden. It was thought, however, that the worth of his table of nutrition from the vegetable kingdom, could lose nothing by a series of carefully conducted analyses, embracing the chief varieties of vegetable food consumed by men. It was, moreover, conceived, that in substances containing so small a per centage of nitrogen as grains and roots generally, the method of Messrs. Varrentrapp and Will for determining nitrogen, would give more accurate results than that of Dumas, employed by Boussingault. The analyses hereafter given, of the same substance, rarely varied from each other more than one tenth of one per cent.; and yet the determinations which follow, and those of similar substances made by the distinguished French chemist, in general differ no farther from each other than might be expected, from productions of the same vegetable species, grown on different soils.

Buckwheat (*Polygonum fagopyrum*) constitutes an exception to this remark. In the table of analytical results, page 294, Boussingault's Economie Rurale, (Ger. Edition), this grain has a nitrogen percentage of 2.40, while two ordinary varieties of wheat (*Triticum vulgare*) have 2.33 and 2.30 per cent. Buckwheat meal from Vienna gave, as shown below, 1.08 per cent. Buckwheat grains (*Polygonum Tartaricum*) from the experimental field of the Hohenheim Agricultural Institute, gave 1.56 per cent. of nitrogen, while the analyses of three superior varieties of wheat, grown in the same field, gave respectively 2.59, 2.68 and 2.69 per cents. This species was further found to contain 22.66 per cent. of woody fibre.

The equivalent value of Buckwheat, according to Boussin-

gault, wheat being 1.00, is 1.08. The following analyses give, for its equivalent value, 1.70. For that of the Vienna Buckwheat meal, 2.45.

For the following investigation the meals, table peas and beans and lentils were procured by Prof. v. Liebig, from Vienna. The grains, with the exception of Rice and *Triticum monococcum*, were furnished from the cabinet of the Hohenheim Agricultural Institute, in the kingdom of Würtemberg, in reply to a request for the most approved sorts of cerealia cultivated in Europe. The roots were from Giessen.

The several meals, grains, and roots, in their market condition, were dried in a water-bath at 100° C. (212 Fah.)

In drying the potatoes, beets, carrots and turnips, care was taken to cut as thin shavings as possible, which with the least delay were placed singly upon watch glasses, weighed and seated in the water-bath.

For carbon and hydrogen, the combustions were made with oxide of copper, a mixture of chlorate of potash and oxide of copper, having been placed at the extremity of the combustion tube.

It was found difficult to reduce the woody fibre of the oats, barley and buckwheat, to the requisite fineness for a complete combustion. Where the difficulty could not readily be overcome, in addition to chlorate of potash at the extremity of the tube, it was found well, in filling with mixed substance and oxide of copper, to add, at intervals of an inch and a half, a small quantity of finely pulverized and thoroughly mixed oxide of copper and chlorate of potash. The successive evolutions of oxygen in this case, thoroughly reoxidized any portions of copper reduced in the progress of combustion, and secured the most satisfactory results.

Difficulty presented itself also in the combustion of the potatoes, beets and other roots, arising from the extreme compactness of the substance when dried. It was, however, overcome by the method already mentioned.

The nitrogen determinations, as already intimated, were according to the method of Messrs. Varrentrapp and Will.

The per centage of woody fibre was determined in the following manner. Grains, such as had been analyzed, were digested upon a sand-bath several weeks in dilute hydrochloric acid, one part of acid to a thousand parts of water. At intervals of from eight to ten days, the fluid was poured off, and, with diluted acid as before, the digestion resumed. After a month and a half, the woody fibre not appearing wholly freed from this substance, an equally dilute solution of caustic potash was employed, and the digestion therewith resumed. At the end of two months the woody fibre of the oats, barley and buckwheat were poured upon filters, thoroughly washed with distilled water, and dried at 100° C.

Of beans and peas the hulls, separated by treating with cold water, were alone digested with dilute caustic potash, repeatedly pouring off the liquid and resuming the digestion afresh. At the conclusion of four weeks, the hulls were washed and dried at 100° C.

To express in hundred parts the results of analysis, the carbon, hydrogen, oxygen, and sulphur of the nitrogenous ingredients were estimated from the per centage of nitrogen.*

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* Mulder's analysis of coagulated albumen, Scheerer and Jones's analyses of legumin and gluten (Annalen der Chemie und Pharmacie, XXXIX. page 360); and Heldt's analysis of the gluten of rye (Annalen der Chemie und Pharmacie, XLV. page 198), differ so little from each other, that a single formula has been constructed upon Mulder's analysis of coagulated albumen, and with a little modification employed in determining the elements of the nitrogenous ingredients of all the substances subjected to investigation.

Mulder's per centage of oxygen was reduced by that of the sulphur, which has been ascertained during the last session of the Giessen Laboratory, and kindly furnished to me by Dr. Ruling. It is for gluten 1.14 per cent., and for legumin 0.50 per cent.

The still undetermined phosphorus is included in the oxygen.

Below follow the analyses alluded to above.

The carbon and hydrogen so estimated, deducted from the whole per centage of carbon and hydrogen, gave what belonged to the starch, gum, woody fibre, sugar, &c. The oxygen of the latter was estimated from the carbon, by the formula

$$C_{12}\, H_{10}\, O_{10}.*$$

	Gluten. Scheerer.	Jones.	Coagulated Albumen. Mulder.
Carbon	54.60	55.22	54.99
Hydrogen	7.30	7.42	6.87
Nitrogen	15.81	15.98	15.66
Oxygen, P. & S.	22.28	21.38	22.48
	Legumen. *Scheerer.*	*Jones.*	**Gluten of Rye.** *Heldt.*
Carbon	54.13	55.05	56.38
Hydrogen	7.15	7.59	7.87
Nitrogen	15.67	15.89	15.83
Oxygen, P. & S.	23.03	21.47	19.96

The numbers employed were

Carbon	54.99	
Hydrogen	6.87	
Nitrogen	15.66	
Sulphur	1.14	— 0.50
Oxygen and Phosphorus	20.92	— 21.98

Mucin, discovered by Berzelius, is recognized among the nitrogenous compounds. As analyses of vegetable fibrine and vegetable albumen, with and without it, according to Prof. v. Liebig, give the same result, it may be presumed that its composition is identical with theirs.

* The following list of the chief bodies present in the substances analyzed, with their annexed constitution, will justify the method pursued.

Starch	$C_{12}\, H_{10}\, O_{10}$
Dextrine	$C_{12}\, H_{10}\, O_{10}$
Gum	$C_{12}\, H_{10}\, O_{10}$
Woody fibre, Payen	$C_{12}\, H_{10}\, O_{10}$
Cane sugar	$C_{12}\, H_{11}\, O_{11}$
Pectic acid, dried by 140° C, Regnault	$C_{12}\, H_{8}\, O_{11}$
Pectic acid, Mulder	$C_{12}\, H_{8}\, O_{10}$
Pectin combined with Pb O, Fremy	$C_{10}\, H_{9}\, O_{11}$

Starch and woody fibre exceed in per centage, all the other ingredients enumerated, in most of the substances analyzed; and are, beside, identical in constitution with gum and dextrine.

WHEAT FLOUR, from Vienna. No. 1.

Water.

I. 1.0883 grammes lost at 100° C. (212° Fah.)
0.9378 gr. water.

Ashes.

II. 1.309 gr. of the flour dried at 100°, left after incineration 0.0091 gr.

III. 0.862 gr. of the same gave 0.0061 gr. ashes.

Elementary analysis.

IV. 0.3805 gr. of the same, burned with the oxide of copper, gave
0.6370 gr. carbonic acid, and
0.2186 " water.

V. 0.4190 " of the same, gave
0.7020 " carbonic acid, and
0.2550 " water.

VI. 0.3671 " of the same, gave
0.6189 " carbonic acid, and
0.2374 " water.

VII. 0.8078 " of the same, gave, by Varrentrapp and Will's method for determining Nitrogen, 0.3925 gr. platin-salammoniac.

VIII. 0.8078 gr. of the same, gave
0.3893 " platin-salammoniac.

These determinations give, in per cent. expressed,

		I.	II.	III.
Carbon	=	45.66	45.69	45.97
Hydrogen	=	6.38	6.76	6.96
Nitrogen	=	3.05	2.99	
Ashes	=	0.67	0.70	
Water	=	13.83		

Estimated in hundred parts, according to the composition

of the chief ingredients present, the above determinations give the following numbers.

Nitrogenous ingredients.	Nitrogen	3.00	= 19.16
	Carbon	10.53	
	Hydrogen	1.31	
	Oxygen	4.09	
	Sulphur	0.23	
Ingredients containing no Nitrogen.	Carbon	35.23	= 79.77
	Hydrogen	5.39	
	Oxygen	39.15	
	Ashes - -		= 0.70
			99.63

WHEAT FLOUR, from Vienna. No. 2.

I.	3.6365 gr. lost at 100° C. 0.4964 gr. water.		
II.	1.2599	"	of substance dried at 100° C. gave
	0.0084	"	ashes.
III.	0.3643	"	of the same, gave
	0.6015	"	carbonic acid, and
	0.2175	"	water.
IV.	0.5429	"	of the same, gave
	0.9022	"	carbonic acid, and
	0.2175	"	water.
V.	0.8705	"	of the same, gave
	0.2974	"	platin-salammoniac.
VI.	0.698	"	of the same, gave
	0.2331	"	platin-salammoniac.

The above correspond, in per cent. expressed, to

	I.	II.
Carbon	45.03	45.32
Hydrogen	6.67	6.63
Nitrogen	2.14	2.10
Ashes	0.67	
Water	13.65	

Estimated in hundred parts, according to the constitution of the principal bodies present, the above determinations give

Nitrogenous ingredients.	Nitrogen	2.12	= 13.53
	Carbon	7.44	
	Hydrogen	0.93	
	Oxygen	2.89	
	Sulphur	0.15	
Ingredients containing no Nitrogen.	Carbon	37.73	= 85.37
	Hydrogen	5.72	
	Oxygen	41.92	
	Ashes - -		= 0.66
			99.56

WHEAT FLOUR, from Vienna. No. 3.

I. 3.5345 gr. at 100° C. lost
0.4500 "

II. 4.4785 " of flour, dried at 100°, gave
0.0497 " ashes.

III. 0.5545 " of the same, gave
0.9339 " carbonic acid, and
0.3377 " water.

IV. 0.3310 " of the same, gave
0.5655 " carbonic acid, and
0.2031 " water.

V. 0.6405 " of the same, gave
0.3514 " platin-salammoniac.

These, in per cent. expressed, correspond to

	I.	II.
Carbon	45.93	46.59
Hydrogen	6.76	6.81
Nitrogen	3.44	
Ashes	1.11	
Water	12.73	

Estimated in hundred parts according to the composition

of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	3.44	= 21.93
	Carbon	12.08	
	Hydrogen	1.50	
	Oxygen	4.68	
	Sulphur	0.25	
Ingredients containing no Nitrogen.	Carbon	34.97	= 78.03
	Hydrogen	5.28	
	Oxygen	37.97	
	Ashes -	-	= 1.11
			100.09

TALAVERA WHEAT, from Hohenheim.

Triticum vulgare. This variety is of high reputation as a winter grain. Berry yellow, of medium size, and slightly shrunk.

Ten kernels weighed 0.3606 gr.

I. 2.3010 gr. lost, at 100° C., 0.3551 gr. water.
II. 3.9868 " of substance, dried at 100° C., gave
0.1116 " ashes.
III. 0.2796 " of the same, gave
0.3915 " carbonic acid, and
0.1672 " water.
IV. 0.2387 " of the same, gave
0.3915 " carbonic acid, and
0.1427 " water.
V. 0.6429 " of the same, gave
0.2711 " platin-salammoniac.

The above correspond, in per cent., with

	I.	II.
Carbon	45.14	44.73
Hydrogen	6.64	5.97
Nitrogen	2.59	
Ashes	2.80	
Water	15.43	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	2.59	= 16.54
	Carbon	9.09	
	Hydrogen	1.13	
	Oxygen	3.55	
	Sulphur	0.18	
Ingredients containing no Nitrogen.	Carbon	35.84	= 80.78
	Hydrogen	5.12	
	Oxygen	39.82	
	Ashes	- -	= 2.80
			100.12

WHITINGTON WHEAT, Hohenheim.

Triticum vulgare. An English variety, of great excellence. Berry yellow or white, large, and slightly shrunk.

Ten kernels weighed 0.4239 gr.

I. 2.6221 gr. lost, at 100° C.,
0.3653 " water.

II. 4.6567 " of substance, dried at 100°, gave
0.1460 " ashes.

III. 0.2927 " of the same, gave
0.4747 " carbonic acid, and
0.1834 " water.

IV. 0.3898 " of the same, gave
0.6377 " carbonic acid, and
0.2343 " water.

V. 0.5494 " of the same, gave
0.2343 " platin-salammoniac.

In per cent. the above correspond to

	I.	II.
Carbon	44.23	44.61
Hydrogen	6.96	6.67
Nitrogen	2.68	
Ashes	3.13	
Water	13.93	

Estimated in hundred parts, according to the constitution of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.68	
	Carbon	9.40	
	Hydrogen	1.17	= 17.09
	Oxygen	3.65	
	Sulphur	0.19	
Ingredients containing no Nitrogen.	Carbon	35.02	
	Hydrogen	5.65	= 78.58
	Oxygen	38.91	
	Ashes	- -	= 3.13
			99.80

SANDOMIERZ WHEAT, Hohenheim.

Triticum vulgare. Berry scarcely of medium size, plump and sound. This variety is known as one of the best in Germany.

I.	4.2256	gr.	at 100° C., lost
	0.6545	"	water.
II.	3.6555	"	of substance, dried at 100° C., gave
	0.0886	"	ashes.
III.	0.5754	"	of the same, gave
	0.9327	"	carbonic acid, and
	0.3465	"	water.
IV.	0.7303	"	of the same, gave
	0.3131	"	platin-salammoniac.

In per cent. the above corresponds to

Carbon	44.20
Hydrogen	6.68
Nitrogen	2.69
Ashes	2.40
Water	15 48

Estimated in hundred parts, according to the composition

of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.69	= 17.15
	Carbon	9.44	
	Hydrogen	1.17	
	Oxygen	3.66	
	Sulphur	0.19	
Ingredients containing no Nitrogen.	Carbon	34.76	= 78.89
	Hydrogen	5.51	
	Oxygen	38.62	
	Ashes	- -	= 2.40
			98.44

RYE FLOUR, from Vienna. No. 1.

I.	3.253	gr.	lost, at 100° C.,
	0.4482	"	water.
II.	2.889	"	of flour, dried at 100° C., gave
	0.0387	"	ashes.
III.	3.2285	"	of the same, gave
	0.0427	"	ashes.
IV.	0.3383	"	of the same, gave
	0.5576	"	carbonic acid, and
	0.1983	"	water.
V.	0.3109	"	of the same, gave
	0.5055	"	carbonic acid, and
	0.1901	"	water.
VI.	0.6519	"	of the same, gave
	0.1941	"	platin-salammoniac.

In per cent. expressed, the above correspond with

	I.	II.
Carbon	44.41	44.32
Hydrogen	6.51	6.79
Nitrogen	1.87	
Ashes	1.34	1.32
Water	13.78	

Estimated in hundred parts, according to the composition

of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.87	= 11.92
	Carbon	6.56	
	Hydrogen	0.82	
	Oxygen	2.54	
	Sulphur	0.13	
Ingredients containing no Nitrogen.	Carbon	37.81	= 85.65
	Hydrogen	5.83	
	Oxygen	42.01	
	Ashes	- -	= 1.33
			98.90

RYE FLOUR, from Vienna. No. 2.

I.	7.4625	gr.	lost, at 100° C.,
	1.0956	"	water.
II.	2.8000	"	of flour, dried at 100° C., gave
	0.0300	"	ashes.
III.	0.5312	"	of the same, gave
	0.8752	"	carbonic acid, and
	0.3116	"	water.
IV.	0.4577	"	of the same, gave
	0.7626	"	carbonic acid, and
	0.2720	"	water.
V.	0.7558	"	of the same, gave
	0.3537	"	platin-salammoniac.
VI.	0.7378	"	of the same, gave
	0.3433	"	platin-salammoniac.

In per cent. expressed, these correspond to

	I.	II.
Carbon	44.94	45.44
Hydrogen	6.52	6.60
Nitrogen	2.94	2.92
Ashes	1.07	
Water	14.68	

Estimated in hundred parts, according to the composition

of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.93	= 18.69
	Carbon	10.28	
	Hydrogen	1.28	
	Oxygen	3.99	
	Sulphur	0.21	
Ingredients containing no Nitrogen.	Carbon	34.91	= 78.97
	Hydrogen	5.28	
	Oxygen	38.78	
	Ashes - -		= 1.08
			98.74

Bush Rye, from Hohenheim.

Secale cereale. Winter crop. In the Hohenheim catalogue, is the following remark. "Beside its other qualities, this variety yields such excellent straw, that it deserves being mentioned." The berry is small, and generally shrunken.

Ten kernels weighed 0.1220 gr.

I.	4.2303 gr.	lost, at 100° C.,
	0.5896 "	water.
II.	4.3792 "	of substance, dried at 100° C., gave
	0.1078 "	ashes.
III.	0.4742 "	of the same, gave
	0.7879 "	carbonic acid, and
	0.2767 "	water.
IV.	0.6281 "	of the same, gave
	1.0555 "	carbonic acid, and
	0.3777 "	water.
V.	0.6807 "	of the same, gave
	0.3016 "	platin-salammoniac.

In per cent. the above correspond to

	I.	II.
Carbon	45.31	45.83
Hydrogen	6.48	6.68
Nitrogen	2.78	
Ashes	2.43	
Water	13.94	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.78	= 17.73
	Carbon	9.76	
	Hydrogen	1.21	
	Oxygen	3.78	
	Sulphur	0.20	
Ingredients containing no Nitrogen.	Carbon	35.76	= 80.86
	Hydrogen	5.37	
	Oxygen	39.73	
	Ashes	- -	= 2.43
			101.02

RUSH RYE, from Hohenheim.

Secale cereale arundinaceum. Berry of medium size, and slightly shrunken.

Ten kernels weighed 0.1838 gr.

I.	3.3139 gr.	lost, at 100 C.,
	0.4579 "	water.
II.	1.4596 "	of substance, dried at 100° C., gave
	0.0346 "	ashes.
III.	0.2795 "	of the same, gave
	0.4620 "	carbonic acid, and
	0.1742 "	water.
IV.	0.2632 "	of the same, gave
	0.4381 "	carbonic acid, and
	0.1638 "	water.
V.	0.6435 "	of the same, gave
	0.2530 "	platin-salammoniac.

These correspond to, in per cent.,

	I.	II.
Carbon	45.08	45.39
Hydrogen	6.92	6.22
Nitrogen	2.47	
Ashes	2.37	
Water	13.82	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give the following numbers.

Nitrogenous ingredients.	Nitrogen	2.47	= 15.76
	Carbon	8.67	
	Hydrogen	1.08	
	Oxygen	3.36	
	Sulphur	0.18	
Ingredients containing no Nitrogen.	Carbon	36.56	= 82.67
	Hydrogen	5.49	
	Oxygen	40.62	
	Ashes	- -	= 2.37
			100.80

POTENTA MEAL (Indian Corn Meal), Vienna.

Yellow, and coarse.

I. 5.5810 gr. lost, at 100° C.,
0.7456 " water.
II. 4.3933 " of meal, dried at 100° C., gave
0.0386 " ashes.
III. 3.9323 " of the same, gave
0.0331 " ashes.
IV. 0.5444 " of the same, gave
0.9010 " carbonic acid, and
0 3330 " water.
V. 0.5095 " of the same, gave
0.8399 " carbonic acid, and
0.2943 " water.
VI. 9.9055 " of the same, gave
0.3093 " platin-salammoniac.

These correspond to, in per cent.,

	I.	II.
Carbon	45.14	44.96
Hydrogen	6.89	6.49
Nitrogen	2.14	
Ashes	0.87	0.84
Water	13.36	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.14	= 13.65
	Carbon	7.51	
	Hydrogen	0.93	
	Oxygen	2.92	
	Sulphur	0.15	
Ingredients containing no Nitrogen.	Carbon	37.53	= 84.90
	Hydrogen	5.67	
	Oxygen	41.70	
	Ashes	- -	= 0.86
			99.41

Common Yellow Maize (Indian Corn). Hohenheim.

Zea mais. Berry oval, bright and sound.

Ten corns weighed 3.5934 gr.

I. 4.5765 gr. lost, at 100° C.,
0.6849 " water.
II. 5.0654 " of substance, dried at 100° C., gave
0.0974 " ashes.
III. 0.4164 " of the same, gave
0.6984 " carbonic acid, and
0.2468 " water.
IV. 0.4103 " of the same, gave
0.6800 " carbonic acid, and
0.2684 " water.
V. 0.7319 " of the same, gave
0.2684 " platin-salammoniac.

These correspond, in per cent., with

	I.	II.
Carbon	45.74	45.20
Hydrogen	6.58	6.64
Nitrogen	2.30	
Ashes	1.92	
Water	14.96	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.30	= 14.66
	Carbon	8.07	
	Hydrogen	1.00	
	Oxygen	3.13	
	Sulphur	0.16	
Ingredients containing no Nitrogen.	Carbon	37.38	= 84.52
	Hydrogen	5.61	
	Oxygen	41.53	
	Ashes	- -	= 1.92
			101.10

Triticum Monococcum. Giessen-Wheat.

I. 4.4914 gr. lost, at 100° C.,
0.6472 " water.
II. 7.1327 " of substance, dried at 100° C., gave
0.1438 " ashes.
III. 0.6303 " of the same, gave
1.0288 " carbonic acid, and
0.3811 " water.
IV. 0.6757 " of the same, gave
1.1041 " carbonic acid, and
0.4098 " water.
V. 0.7105 " of the same, gave
0.2340 " platin-salammoniac.

These correspond with

	I.	II.
Carbon	44.51	44.56
Hydrogen	6.71	6.74
Nitrogen	2.07	
Ashes	2.01	
Water	14.40	

Estimated in hundred parts, according to the composition of the principal bodies present, the above give

Ingredients containing Nitrogen.	Nitrogen	2.07	= 13.20
	Carbon	7.26	
	Hydrogen	0.90	
	Oxygen	2 82	
	Sulphur	0.15	
Ingredients containing no Nitrogen.	Carbon	37.28	= 84.52
	Hydrogen	5.82	
	Oxygen	41.42	
	Ashes	- -	= 2.01
			99.73

JERUSALEM BARLEY. Hohenheim.

Hordeum distichum. Two-rowed Barley.

Ten kernels weighed 0.5312 gr.

I. 1.9328 gr. lost, at 100° C.,
0.3247 " water.

II. 2.3553 " of substance, dried at 100° C., gave
0.0670 " ashes.

III. 0.4457 " of the same, gave
0.7392 " carbonic acid, and
0.2787 " water.

IV. 0.4603 " of the same, gave
0.7728 " carbonic acid, and
0.2913 " water.

V. 0.6910 " of the same, gave
0.2560 " platin-salammoniac.

These correspond with

	I.	II.
Carbon	45.23	45.78
Hydrogen	6.94	6.79
Nitrogen	2.31	
Ashes	2.84	
Water	16.79	

Estimated in hundred parts, according to the composition

of the principal bodies present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	2.31		
	Carbon	8.11		
	Hydrogen	1.00	=	14.72
	Oxygen	3.14		
	Sulphur	0.16		
Ingredients containing no Nitrogen.	Carbon	37.39		
	Hydrogen	5.87	=	84.80
	Oxygen	41.54		
	Ashes -	-	=	2.84
				102.36

COMMON WINTER BARLEY. Hohenheim.

Hordeum vulgare.

Ten kernels weighed 0.3955 gr.

I.	1.5268	gr.	lost, at 100° C.,
	0.2107	"	water.
II.	2.5708	"	of substance, dried at 100° C., gave
	0.1409	"	ashes.
III.	0.3244	"	of the same, gave
	0.5380	"	carbonic acid, and
	0.1928	"	water.
IV.	0.2505	"	of the same, gave
	0.4152	"	carbonic acid, and
	0.1611	"	water.
V.	0.5266	"	of the same, gave
	0.2342	"	platin-salammoniac.
VI.	4.3619	"	of grains (calculated as dried at 100° C.), gave, by the method already described,
	0.2356	"	woody fibre and combined inorganic matter or chaff and hulls.
VII.	0.1793	"	of the above hulls and chaff, gave
	0.0035	"	ashes.

These results, in per cent., are

	I.	II.
Carbon	45.23	45.20
Hydrogen	6.60	7.14
Nitrogen	2.79	
Ashes	5.52	
Water	13.80	
Hulls and chaff	5.40	
Ashes of same	1.90	

Estimated in hundred parts, according to the composition of the principal ingredients present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	2.79	= 17.70
	Carbon	9.79	
	Hydrogen	1.12	
	Oxygen	3.80	
	Sulphur	0.20	
Ingredients containing no Nitrogen.	Carbon	35.43	= 80.64
	Hydrogen	5.85	
	Oxygen	39.36	
	Ashes -	-	= 5.52
			103.86

	Dried at 100°.	Undried.
Nitrogenous ingredients	17.70	15.26
Inorganic ingredients	5.52	4.76
Woody fibre	5.35	4.57
Starch, sugar, etc.	71.48	61.61
Water		13.80
	100.00	100.00

KAMSCHATKA OATS. Hohenheim.

Avena sativa. A superior variety.

Ten kernels weighed 0.3446 gr.

I. 2.3657 gr. lost, at 100° C.,
0.3018 " water.

II. 3.1728 " of substance, dried at 100° C., gave
0.1032 " ashes.

III. 0.4310 " of the same, gave
0.7341 " carbonic acid, and
0.2552 " water.

IV. 0.4001 " of the same, gave
0.6830 " carbonic acid, and
0.2427 " water.

V. 0.4102 " of the same, gave
0.1581 " platin-salammoniac.

VI. 0.6207 " of the same, gave
0.2324 " platin-salammoniac.

In per cent. expressed, corresponding to

	I.	II.
Carbon	46.45	46.55
Hydrogen	6.55	6.73
Nitrogen	2.42	2.35
Ashes	3.26	
Water	12.71	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	2.39	= 15.24
	Carbon	8.39	
	Hydrogen	1.04	
	Oxygen	3.25	
	Sulphur	0.17	
Ingredients containing no Nitrogen.	Carbon	38.11	= 86.05
	Hydrogen	5.60	
	Oxygen	42.34	
	Ashes	- -	= 3.26
			104.55

Early White Panicled Oats. Hohenheim.

Avena sativa. One of the best varieties known.

Ten kernels weighed 0.3689 gr.

I	1.7548	gr.	lost, at 100° C.,
	0.2271	"	water.
II.	1.8486	"	of substance, dried at 100°C., gave
	0.0765	"	ashes.
III.	0.3539	"	of the same, gave
	0.6057	"	carbonic acid, and
	0.2144	"	water.
IV.	0.2410	"	of the same, gave
	0.4123	"	carbonic acid, and
	0.1451	"	water.
V.	0.4977	"	of the same, gave
	0.2236	"	platin-salammoniac.
VI.	3.5498	"	of kernels, gave by the method already described,
	0.5916	"	hulls and chaff.
VII.	0.4197	"	of the hulls and chaff, gave
	0.0140	"	ashes.

In per cent. corresponding to

	I.	II.
Carbon	46.68	46.66
Hydrogen	6.73	6.69
Nitrogen	2.82	
Ashes	4.14	
Water	12.94	
Hulls and chaff	16.66	
Ashes of same	3.35	

Estimated in hundred parts, according to the composition of principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.82	= 17.99
	Carbon	9.90	
	Hydrogen	1.23	
	Oxygen	3.84	
	Sulphur	0.20	
Ingredients containing no Nitrogen.	Carbon	36.76	= 83.08
	Hydrogen	5.48	
	Oxygen	40.84	
	Ashes	- -	= 4.14
			105.21

	Dried at 100° C.	Undried.
Nitrogenous ingredients	17.99	15.67
Inorganic ingredients	4.14	3.60
Woody fibre	16.10	14.01
Starch, sugar, etc.	61.76	53.78
Water		12.94
	100.00	100.00

As the woody fibre = 16.10 per cent. of the whole, belongs mostly to the chaff, this grain ranks among the richest in nitrogenous compounds; 2.82 per cent. of nitrogen *with* the chaff, equals 3.38 per cent. *without.*

COMMON RICE.

Oryza sativa.

I.	7.4606	gr.	lost, at 100° C.,
	1.1301	"	water.
II.	8.3670	"	of dried substance, gave
	0.0306	"	ashes.
III.	0.7158	"	of the same, gave
	1.1701	"	carbonic acid, and
	0.4244	"	water.
IV.	0.6095	"	of the same, gave
	0.9982	"	carbonic acid, and
	0.3559	"	water.
V.	1.5609	"	of the same, gave
	0.2892	"	platin-salammoniac.

Corresponding, in per cent., to

	I.	II.
Carbon	44.57	44.66
Hydrogen	6.58	6.48
Nitrogen	1.16	
Ashes	0.36	
Water	15.14	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.16	= 7.40
	Carbon	4.07	
	Hydrogen	0.51	
	Oxygen	1.58	
	Sulphur	0.08	
Ingredients containing no Nitrogen.	Carbon	40.54	= 91.60
	Hydrogen	6.02	
	Oxygen	45.04	
	Ashes -	-	= 0.36
			99.36

BUCKWHEAT MEAL, Vienna.

I.	7.3962 gr.	lost, at 100° C.,
	1.1187 "	water.
II	5.1500 "	of meal, dried at 100° C., gave
	0.0564 "	ashes.
III.	0.5041 "	of the same, gave
	0.8194 "	carbonic acid, and
	0.2911 "	water.
IV.	0.3441 "	of the same, gave
	0.5577 "	carbonic acid, and
	0.2061 "	water.
V.	1.1295 "	of the same, gave
	0.2062 "	platin-salammoniac.
VI.	0.9536 "	of the same, gave
	0.1561 "	platin-salammoniac.

The above correspond, in per cent., with

	I.	II.
Carbon	44.36	44.20
Hydrogen	6.42	6.68
Nitrogen	1.14	1.03
Ashes	1.09	
Water	15.12	

Estimated in hundred parts, according to the composition of the principal ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.08	= 6.88
	Carbon	3.79	
	Hydrogen	0.47	
	Oxygen	1.47	
	Sulphur	0.07	
Ingredients containing no Nitrogen.	Carbon	40.48	= 91.52
	Hydrogen	6.07	
	Oxygen	44.97	
	Ashes	- -	= 1.09
			99.49

TARTARIAN BUCKWHEAT, Hohenheim.

Polygonum tartaricum. This species differs from P. fagopyrum (the common species) in that, while the hulls of the latter are smooth, those of the former are covered with folds and excrescences. The whole grain, hull included, was pulverized and analyzed.

Ten kernels weighed 0.2566 gr.

I.	2.7598	gr.	lost, at 100° C.,
	0.3916	"	water.
II.	2.5924	"	of substance, dried at 100°C., gave
	0.0597	"	ashes.
III.	0.4245	"	of the same, gave
	0.7013	"	carbonic acid, and
	0.2503	"	water.
IV.	0.3401	"	of the same, gave
	0.5710	"	carbonic acid, and
	0.1943	"	water.
V.	0.5677	"	of the same, gave
	0.1407	"	platin-salammoniac.
VI.	5.0444	"	of kernels (calculated upon substance dried at 100° C.) gave, by the method already described,
	1.1438	"	hulls.
VII.	0.7100	"	of the above hulls gave
	0.0006	"	ashes.

These correspond, in per cent., with

	I.	II.
Carbon	45.06	45.79
Hydrogen	6.55	6.35
Nitrogen	1.56	
Ashes	2.30	
Water	14.19	
Hulls	22.67	
Ashes of hulls	0.08	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	1.56	= 9.94
	Carbon	5.47	
	Hydrogen	0.68	
	Oxygen	2.12	
	Sulphur	0.11	
Ingredients containing no Nitrogen.	Carbon	40.29	= 90.38
	Hydrogen	5.77	
	Oxygen	44.32	
	Ashes - -		= 2.30
			102.62

	Dried at 100° C.	Undried.
Nitrogenous ingredients	9.94	7.94
Inorganic ingredients	2.30	1.97
Woody fibre	22.66	19.44
Starch, sugar, etc.	65.40	56.46
Water		14.19
	100.00	100.00

TABLE PEAS, Vienna.

Pisum sativum. Bright, plump and sound kernels, of medium size.

Ten weighed 2.6080 gr.

I.	4.4804 gr.	lost, at 100° C.,
	0.6018 "	water.
II.	2.1600 "	of substance, dried at 100° C., gave
	0.0687 "	ashes.
III.	0.4527 "	of the same, gave
	0.7476 "	carbonic acid, and
	0.2789 "	water.
IV.	0.3810 "	of the same, gave
	0.6314 "	carbonic acid, and
	0.2272 "	water.
V.	0.8603 "	of the same, gave
	0.6047 "	platin-salammoniac.
VI.	5.2332 "	of kernels (calculated for substance dried at 100° C.) gave, by the method already described,
	0.4005 "	hulls.
VII.	0.3962 "	of the above hulls, gave
	0.0098 "	ashes.

These determinations, expressed in per cent., correspond to

	I.	II.
Carbon	45.04	45.20
Hydrogen	6.84	6.62
Nitrogen	4.42	
Ashes	3.18	
Water	13.43	
Hulls	7.65	
Ashes of same	2.47	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above results give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	4.42	= 28.02
	Carbon	15.51	
	Hydrogen	1.93	
	Oxygen	6.02	
	Sulphur	0.14	
Ingredients containing no Nitrogen.	Carbon	29.61	= 68.31
	Hydrogen	4.80	
	Oxygen	32.90	
	Ashes	- -	= 3.18
			98.51

By estimating the nitrogenous ingredients according to the analysis of legumin by Dumas and Cahours,* the above determinations gave 102.00, instead of 98.51.

	Dried at 100° C.	Undried.
Nitrogenous ingredients	28.02	24.41
Inorganic ingredients	3.18	2.75
Woody fibre	7.47	6.46
Starch, sugar, etc.	61.35	52.95
Water		13.43
	100.00	100.10

* Their analysis gave; Carbon = 50.5, Hydrogen = 6.8, Nitrogen = 18.5, Oxygen = 24.1. Ann. de Ch. et. Phys. VI. 385.

FIELD PEAS, Giessen.

Pisum sativum. Less in size than the preceding variety.

Ten kernels weighed 1.9829 gr.

I.	3.5904	gr.	lost, at 100° C.,
	0.7002	"	water.
II.	2.2455	"	of substance, dried at 100° C., gave
	0.0628	"	ashes.
III.	0.6178	"	of the same, gave
	1.0267	"	carbonic acid, and
	0.3572	"	water.
IV.	0.6467	"	of the same, gave
	0.4708	"	platin-salammoniac.
V.	31.9250	"	of kernels (estimated as dried at 100°) gave, by the method already described,
	1.9510	"	hulls.
VI.	0 7232	"	of the above hulls, gave
	0.0135	"	ashes.

These, in per cent., correspond to

Carbon	45.32
Hydrogen	6.42
Nitrogen	4.57
Ashes	2.79
Water	19 50
Hulls	6.11

Estimated in hundred parts, according to the composition of the principal ingredients present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	4.57	= 29.18
	Carbon	16.04	
	Hydrogen	2.00	
	Oxygen	6.43	
	Sulphur	0.14	
Ingredients containing no Nitrogen.	Carbon	29.28	= 66.23
	Hydrogen	4.42	
	Oxygen	32.53	
	Ashes - -		= 2.79
			98.10

Legumin, according to the analysis of Dumas and Cahours, gave, for the above determinations, 101.06.

	Dried at 100° C.	Undried.
Nitrogenous ingredients	29.18	23.49
Inorganic ingredients	2.79	2.24
Woody fibre	6.00	4.83
Starch, gum, etc.	62.03	51.14
Water		19.50
	100.00	100.00

Table Beans, Vienna.

Phaseolus vulgaris. Berry bright, plump, of less than medium size, and sound.

Ten weighed 3.1431 gr.

I. 2.9467 gr. lost, at 100° C.,
0.3953 " water.

II. 2.8422 " of substance, dried at 100° C., gave
0.1244 " ashes.

III. 0.4648 " of the same, gave
0.7721 " carbonic acid, and
0.2747 " water.

IV. 0.4334 " of the same, gave
0.7126 " carbonic acid, and
0.2617 " water.

V.	0.9082	gr.	of the same, gave
	0.6457	"	platin-salammoniac.
VI.	13.6091	"	of the kernels (estimated as dried at 100° C.) gave, by the method already described,
	0.5461	"	hulls.
VII.	0 5510	"	of the above hulls, gave
	0.0212	"	ashes.

The above results correspond, in per cent., with

	I.	II.
Carbon	45.30	45.84
Hydrogen	6.56	6.76
Nitrogen	4.47	
Ashes	4.38	
Water	13.41	
Hulls	4.11	
Ashes of hulls	3.84	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	4.47	= 28.54
	Carbon	15.69	
	Hydrogen	1.95	
	Oxygen	6.39	
	Sulphur	0.14	
Ingredients containing no Nitrogen.	Carbon	29.38	= 66.70
	Hydrogen	4.68	
	Oxygen	32.64	
	Ashes	- -	= 4.38
			99.63

According to Dumas and Cahours's analysis of legumin, the above determinations give 102.99.

	Dried at 100° C.	Undried.
Nitrogenous ingredients	28.54	24.71
Inorganic ingredients	4.38	3.79
Woody fibre	3.86	3.34
Starch, sugar, etc.	63.22	54.75
Water		13.41
	100.00	100.00

LARGE WHITE BEANS, Giessen.

Vicia faba. Kernels white, plump and sound.

Ten weighed 5.289 gr.

I.	7.4054	gr.	lost, at 100° C.,
	1.1705	"	water.
II.	2.7950	"	of substance, dried at 100° C., gave
	0.1156	"	ashes.
III.	0.4987	"	of the same, gave
	0.8255	"	carbonic acid, and
	0.3053	"	water.
IV.	0.7238	"	of the same, gave
	0.5291	"	platin-salammoniac.
V.	45.5335	"	of kernels (calculated as dried at 100° C.) gave, by the method already described,
	1.9680	"	hulls.
VI.	0.8335	"	of the above hulls, dried at 100° C.,
gave	0.0624	"	ashes.

In per cent. expressed, these correspond to

Carbon	45.18
Hydrogen	6.80
Nitrogen	4.59
Ashes	4.01
Water	15.80
Hulls	4.41
Ashes of hulls	7.48
Woody fibre	4.09

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give the following numbers.

Ingredients containing Nitrogen.	Nitrogen	4.59	= 29.31
	Carbon	16.11	
	Hydrogen	2.00	
	Oxygen	6.47	
	Sulphur	0.14	
Ingredients containing no Nitrogen.	Carbon	29.07	= 66.17
	Hydrogen	4.80	
	Oxygen	32.30	
	Ashes - -		= 4.01
			99.49

According to Dumas and Cahours's analysis of legumin, the above determinations give 102.73.

	Dried at 100° C.	Undried.
Nitrogenous ingredients	29.31	24.67
Inorganic ingredients	4.01	3.37
Woody fibre	4.09	3.44
Starch, etc.	62.59	52.72
Water		15.80
	100.00	100.00

Lentils, Vienna.

Ervum lens. Kernels bright and sound.

I. 9.3074 gr. kernels lost, at 100° C.,
1.2108 " water.

II. 2.1669 " meal lost, at 100° C.,
0.2820 " water.

III. 1.4724 " of dried substance, gave
0.0402 " ashes.

IV. 0.3511 " of the same, gave
0.5813 " carbonic acid, and
0.2122 " water.

V. 0.3863 " of the same, gave
0.6452 " carbonic acid, and
0.2362 " water.

VI. 0.6797 " of the same, gave
0.5198 " platin-salammoniac.

These correspond with, in per cent.,

	I.	II.
Carbon	45.15	45.55
Hydrogen	6.71	6.79
Nitrogen	4.77	
Ashes	2.60	
Water	13.01	13.01

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	4.77	= 30.46
	Carbon	16.74	
	Hydrogen	2.08	
	Oxygen	6.72	
	Sulphur	0.15	
Ingredients containing no Nitrogen.	Carbon	28.61	= 65.06
	Hydrogen	4.67	
	Oxygen	31.78	
	Ashes	- -	= 2.60
			98.12

According to the analysis of legumin by Dumas and Cahours, the above determinations gave 101.34.

White Potatoes, Giessen.

Solanum tuberosum.

I.	1.1455 gr.	lost, at 100° C.,
	0.8586 "	water.
II.	3.2201 "	of substance, dried at 100° C., gave
	0.1163 "	ashes.
III.	0.5814 "	of the same, gave
	0.9351 "	carbonic acid, and
	0.3139 "	water.
IV.	1.1530 "	of the same, gave
	0.2843 "	platin-salammoniac.

These, in per cent., correspond with

Carbon	43.86
Hydrogen	6.00
Nitrogen	1.56
Ashes	3.61
Water	74.95

Estimated in hundred parts, according to the composition of the principal ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.56	= 9.96
	Carbon	5.47	
	Hydrogen	0.68	
	Oxygen	2.14	
	Sulphur	0.11	
Ingredients containing no Nitrogen.	Carbon	38.39	= 86.36
	Hydrogen	5.32	
	Oxygen	42.65	
	Ashes	- -	= 3.61
			99.93

BLUE POTATOES, Giessen.

Solanum tuberosum.

I. 2.8369 gr. lost, at 100° C.,
1.9558 " water.
II. 3.6446 " of substance, dried at 100° C., gave
0.1226 " ashes.
III. 0.8315 " of the same, gave
1.3260 " carbonic acid, and
0.4711 " water.
IV. 0.7625 " of the same, gave
1.2030 " carbonic acid, and
0.4345 " water.
V. 1.3485 " of the same, gave
0.2587 " platin-salammoniac.

These, in per cent. expressed, correspond with

	I.	II.
Carbon	43.49	43.02
Hydrogen	6.29	6.33
Nitrogen	1.20	
Ashes	3.36	
Water	68.94	

Estimated in hundred parts, according to the composition of the principal bodies present, the above determinations give the following numbers.

Nitrogenous Ingredients.	Nitrogen	1.20	= 7.66
	Carbon	4.21	
	Hydrogen	0.52	
	Oxygen	1.65	
	Sulphur	0.08	
Ingredients containing no Nitrogen.	Carbon	39.04	= 88.20
	Hydrogen	5.79	
	Oxygen	43.37	
	Ashes	- -	= 3.36
			99.22

Carrots, Giessen.

Daucus carota.

I. 2.6735 gr. lost, at 100° C.,
2.3021 " water.
II. 1.6379 " of substance, dried at 100° C., gave
0.0946 " ashes.
III. 0.6668 " of the same, gave
1.0597 " carbonic acid, and
0.3736 " water.
IV. 0.6797 " of the same, gave
0.1885 " platin-salammoniac.
V. 0.7043 " of the same, gave
0.1790 " platin-salammoniac.

These, in per cent., correspond with

	I.	II.
Carbon	43.34	
Hydrogen	6.22	
Nitrogen	1.74	1.59
Ashes	5.77	
Water	86.10	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.67	= 10.66
	Carbon	5.87	
	Hydrogen	0.73	
	Oxygen	2.27	
	Sulphur	0.12	
Ingredients containing no Nitrogen.	Carbon	37.47	= 84.59
	Hydrogen	5.49	
	Oxygen	41.63	
	Ashes	- -	= 5.77
			101.02

RED BEET, Giessen.

Beta vulgaris rapacea.

I. 1.6173 gr. lost, at 100° C.,
1.3200 " water.
II. 2.3399 " of substance, dried at 100°C., gave
0.1505 " ashes.
III. 0.4875 " of the same, gave
0.7325 " carbonic acid, and
0.2512 " water.
IV. 0.5505 " of the same, gave
0.2152 " platin-salammoniac.

These correspond with, in per cent.,

Carbon	40.99
Hydrogen	5.72
Nitrogen	2.43
Ashes	6.43
Water	81.61

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	2.43	= 15.50
	Carbon	8.53	
	Hydrogen	1.06	
	Oxygen	3.31	
	Sulphur	0.17	
Ingredients containing no Nitrogen.	Carbon	32.46	= 73.18
	Hydrogen	4.66	
	Oxygen	36.06	
	Ashes	- -	= 6.43
			95.11

Peligot found, in this variety of beet,

10.6	per cent.	*cane sugar*, which with
2.8	"	undried nitrogenous ingredients,
1.1	"	inorganic matter, and
81.6	"	water, leaves only
3.9	"	for woody fibre, starch, etc.
100.	"	parts.

YELLOW FRENCH BEET, Giessen.

Beta cicla.

I. 1.8545 gr. lost, at 100° C.,
1.5255 " water.

II. 2.2840 " of substance, dried at 100° C., gave
0.1148 " ashes.

III.	0.4530 gr.	of the same, gave
	0.6853 "	carbonic acid, and
	0.2587 "	water.
IV.	0.4057 "	of the same, gave
	0.6165 "	carbonic acid, and
	0.2202 "	water.
V.	0.5660 "	of the same, gave
	0.1635 "	platin-salammoniac.

In per cent. these correspond with

	I.	II.
Carbon	41.25	41.45
Hydrogen	6.34	6.03
Nitrogen	1.81	
Ashes	5.02	
Water	82.25	

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Nitrogenous ingredients.	Nitrogen	1.81	= 11.54
	Carbon	6.35	
	Hydrogen	0.79	
	Oxygen	2.46	
	Sulphur	0.13	
Ingredients containing no Nitrogen.	Carbon	34.74	= 78.49
	Hydrogen	5.15	
	Oxygen	38.60	
	Ashes	- -	= 5.02
			95.05

RUTA BAGA, Giessen.

Brassica napobrassica.

I.	2.2981	gr.	lost, at 100° C.,
	1.9139	"	water.
II.	2.5171	"	of substance, dried at 100° C., gave
	0.1010	"	ashes.
III.	0.6762	"	of the same, gave
	1.1226	"	carbonic acid, and
	0.3665	"	water.
IV.	0.6122	"	of the same, gave
	1.0180	"	carbonic acid, and
	0.3306	"	water.
V.	0.7625	"	of the same, gave
	0.1765	"	platin-salammoniac.

These correspond, in per cent., with

	I.	II.
Carbon	45.27	45.35
Hydrogen	6.02	6.00
Nitrogen	1.45	
Ashes	4.01	
Water	83.28	

Estimated in hundred parts, according to the composition of the principal ingredients, the above determinations give

Ingredients containing Nitrogen.	Nitrogen	1.45	= 9.24
	Carbon	5.09	
	Hydrogen	0.63	
	Oxygen	1.97	
	Sulphur	0.10	
Ingredients containing no Nitrogen.	Carbon	40.25	= 90.32
	Hydrogen	5.38	
	Oxygen	44.71	
	Ashes -	-	= 4.01
			103.57

WHITE TURNIPS, Giessen.

Brassica rapa.

I. 0.8742 gr. lost, at 100° C.,
0.7674 " water.

II. 1.7487 " of substance, dried at 100° C., gave
0.1229 " ashes.

III. 0.4376 " of the same, gave
0.6953 " carbonic acid, and
0.2225 " water.

IV. 0.2831 " of the same, gave
0.4472 " carbonic acid, and
0.1548 " water.

V. 0.5976 " of the same, gave
43.42 per cent. carbon, and
5.91 " hydrogen.

VI. 0.7969 gr. of the same, gave
0.2523 " platin-salammoniac.

These correspond in per cent. with

	I.	II.	III.
Carbon	43.33	43.08	43.42
Hydrogen	5.64	6.04	5.91
Nitrogen	1.98		
Ashes	7.03		
Water	87.78		

Estimated in hundred parts, according to the composition of the chief ingredients present, the above determinations give

Bodies containing Nitrogen.	Nitrogen	1.98	= 12.62
	Carbon	6.95	
	Hydrogen	0.86	
	Oxygen	2.69	
	Sulphur	0.14	
Bodies containing no Nitrogen.	Carbon	36.24	= 81.33
	Hydrogen	4.82	
	Oxygen	40.27	
	Ashes -	-	= 7.02
			100.97

WHITE ONIONS, Giessen.

I.	4.3169	gr.	lost, at 100° C.,
	4.0478	"	water.
II.	0.6775	"	of substance, dried at 100° C., gave
	0.0578	"	ashes.
III.	0.6726	"	of the same, gave
	0.1272	"	platin-salammoniac.

The above determinations, expressed in per cent., correspond with

Nitrogen	1.18
Ashes	8.53
Water	93.78

CHAFF AND HULLS, EXPRESSED IN PER CENT.

Name.	Chaff and hulls at 100°.	Ashes of chaff, or hulls.	Woody fibre.
Common winter Barley	5.40	1.90	5 30
Panicled Oats	16.66	3 35	16 10
Tartarian Buckwheat	22.67	0.08	22.66
Table Peas	7.65	2 47	7.47
Field Peas	6.11	1.86	6.00
Table Beans	4.01	3.84	3.86
Large white Beans	4.41	7.48	4.09

RELATIVE WORTH OF INDIVIDUAL KERNELS,

ACCORDING TO THEIR MASS AND PER CENT. OF NITROGEN.

Name.	Ten kernels, in fresh condition, weighed in grammes.	Relative weight of individual kernels Bush Rye taken as unity.	Per cent. of Nitrogen in fresh condition.	Relative amount of Nitrogen in the individual kernels, Rush Rye taken as unity.
Bush Rye	0.1220 gr.	1.	2.39	1.
Rush Rye	0.1838 "	1.5	2.13	1.3
Talavera Wheat	0.3606 "	3.	2.19	2.7
Whitington Wheat	0 4239 "	3.5	2.30	2.9
Sandomierz "	0.3199 "	2.8	2.13	2.4
Indian Corn	3.5934 "	29.4	1.95	24.
Jerusalem Barley	0.5312 "	4.3	1.92	3.6
Common Barley	0.3955 "	3.2	2.40	2.4
Kamschatka Oats	0.3446 "	2.8	2.08	2.4
Early Panicled Oats	0 3689 "	3.	2.45	3.1
Tartarian Buckwheat	0.2566 "	2.1	1.33	1.2
Table Peas	2.6080 "	21.4	3.83	34.3
Field Peas	1.9828 "	16.3	3.68	25.1
Table Beans	3.1431 "	25.5	3.87	41 2
Large White Beans	5 2890 "	43.3	3.86	69.9

TABULAR VIEW

Of Elementary and Inorganic Ingredients, in per cents., of substance dried at 100° *C.*

Name.	Nitrogen.	Carbon.	Hdyrogen.	Oxygen.	Sulphur.	Ashes.
Wheaten Flour, Vienna, No. 1.	3.00	45.74	6.70	43.23	0.23	0.70
" " " No. 2.	2.12	45.18	6.65	44.81	0.15	0.67
" " " No. 3.	3.44	46.86	6.78	42.65	0.25	1.11
Talavera wheat, Hohenheim.	2.59	44.93	6.25	43 35	0.18	2.80
Whitington " "	2.68	44.42	6.82	42.56	0.19	3.13
Sandomierz " "	2.69	44.20	6.68	42.28	0.19	2.40
Rye Flour, Vienna, No. 1.	1.87	44.37	6.65	44.55	0.13	1.33
" " No. 2.	2.93	45.19	6.56	42.77	0.21	1.07
Bush Rye, Hohenheim.	2.78	45.52	6 58	43.51	0.15	0.86
Rush Rye, "	2.47	45.23	6.57	43.98	0.18	2.37
Potenta Meal, Vienna.	2.14	45.04	6.60	44.62	0.15	0.86
Yellow Indian Corn, Hohenheim.	2.30	45.45	6.61	44.66	0.16	1.92
Triticum monococcum, Giessen.	2.07	44.54	6.72	44.24	0.15	2.01
Jerusalem Barley, Hohenheim.	2.31	45.50	6.87	44.68	0.16	2.84
Common winter Barley, Hohen.	2.79	45.22	6.99	42.16	0.20	5 52
Kamschatka Oats, Hohenheim.	2 39	46.50	6.64	45.59	0.17	3.26
Early white panicled Oats, Hoh.	2.82	46.66	6.71	44.68	0.20	4.14
Common Rice,	1.16	44.61	6.53	46.62	0.08	0.36
Buckwheat Flour, Vienna,	1.08	44.27	6.54	46.50	0.07	1.09
Tartarian Buckwheat, Hohen.	1.56	45.42	6.45	46.50	0.11	2.30
Table Peas, Vienna.	4.42	45.12	6.73	37.92	0.14	3.18
Field Peas, Giessen.	4 57	45.33	6.42	38.75	0.14	2.79
Table Beans, Vienna.	4.47	45.07	6.63	38.73	0.14	4.38
Large white Beans, Giessen.	4.59	45.18	6.80	38.55	0.14	4.01
Lentils, Vienna.	4.77	45.35	6.75	38.28	0.15	2.60
White Potatoes, Giessen.	1.56	43.86	6.00	44.77	0.11	3.61
Blue Potatoes, "	1.20	43.25	6.31	45.00	0.08	3.36
Carrots, "	1.67	43.34	6.22	43.90	0.12	5.77
Red Beets, "	2.43	40.99	5.72	39.37	0.17	6.43
Yellow French Beet, "	1.81	41.09	5.94	41.06	0.13	5.02
Ruta Baga, "	1.45	45.31	6.01	42.59	0.10	4.01
White Turnips, "	1.98	43 19	5.68	42.96	0.14	7.02
Onions, "	1.18	—	—	—	—	8.53

TABLE

Of Nitrogenous Ingredients, in per cents.

Name.	Nitrogenous Ingredients.		Water.
	Dried at 100° C.	In fresh condition.	
Wheat Flour, Vienna. No. 1.	19.15	16.51	13.83
" " " No. 2.	13.54	11.69	13.65
" " " No. 3.	21.97	19.17	12.73
Talavera Wheat, Hohenheim	16.54	13.98	15.43
Whitington Wheat, Hohenheim	17.11	14.72	13.93
Sandomierz Wheat, "	17.18	14.51	15.48
Rye Flour, Vienna. No. 1.	11.94	10.34	13.78
" " " No. 2.	18.71	15.96	14.68
Bush Rye, Hohenheim	17.75	15.27	13.94
Rush " "	15.77	13.59	13.82
Polenta Meal, Vienna	13.66	11.53	13.36
Yellow Indian Corn, Hohenheim	14.68	12.48	14.96
Triticum Monococcum, Giessen	13.22	11.30	14.40
Jerusalem Barley, Hohenheim	14.74	12.26	16.79
Common Winter Barley, Hoh.	17.81	15.35	13.80
Kamschatka Oats, Hohenheim	15.26	13.32	12.71
Early panicled Oats	18.00	15.67	12.94
The same, without chaff	21.57	18.78	12.94
Common Rice	7.40	6.27	15.14
Buckwheat Meal, Vienna	6.89	5.84	15.12
Tartarian Buckwheat, Hohenheim	9.96	7.94	14.19
Table Peas, Vienna	28.02	24.41	13.43
Field Peas, Giessen	29.18	23.49	19.50
Table Beans, Vienna	28.54	24.71	13.41
Large White Beans, Giessen	29.31	24.67	15.80
Lentils, Vienna	30.46	26.50	13.01
White Potatoes, Giessen	9.96	2.49	74.95
Blue Potatoes, "	7.66	2.37	68.94
Carrots, Giessen "	10.66	1.48	86.10
Red Beets, "	15.50	2.83	81.61
Yellow French Beet "	11.56	2.04	82.25
Ruta Baga Beet "	9.25	1.54	83.28
White round Turnips	12.64	1.54	87.78
Onions	7.53	0.46	93.78

TABULAR VIEW

Of Nutriment Values expressed in equivalents, Wheat placed at 100.

Name.	Theory. Dried at 100° C.	Theory. In fresh condition.	Experiment. In fresh condition.
Wheat - - -	100.	100.	94.
Rye - - -	98.8	97.6	97.6
Indian Corn - -	115.	113.	108.
Triticum monococcum -	128.	124.6	——
Barley - - -	104.	102.	101.5
Panicled Oats - -	92.	90.	112.7
The same, without chaff	78.	76.3	——
Kamschatka Oats -	110.	106.	112.7
Common Rice - -	220.	225.	——
Tartarian Buckwheat -	170.	166.	122.7
Table Peas - -	59.9	57.6	90.7
Field Peas - -	57 7	60.	90.7
Table Beans - -	59.2	57.	90.7
Large white Beans -	58.8	57.	94.7
Linsen - - -	55.5	53.	——
White Potatoes - -	169.8	565.6	429.
Blue Potatoes - -	220.8	596.3	429.
Carrots - -	158.6	959.4	545.4
Red Beets - -	109.	501.5	——
Yellow French Beet -	146.	689.5	643.
Ruta Baga - -	182.7	919.4	589.7
White Turnips - -	133.8	919 4	1000.
Onions - - -	224.6	210.6	——

The last column, in the above table, contains the average results of experiments with a view to practical equivalents, as given by Boussingault, pp. 292–295, German ed. One of the results with wheat differs so greatly from the others, that it was neglected.

By comparing the results of the above investigation with each other, and with those previously known, the following conclusions have been arrived at.

That the same species of cereal grain, grown on different soils, may yield unequal percentages of nitrogen.

That wheat and rye flours, to the eye and sense of feeling undistinguishable from each other, may differ by from one to three tenths of their whole quantity of nitrogen.

That one-seventh of fresh, ripe cereal grains, is moisture, that may be expelled at a temperature of 100° C.

That root crops, grown on different soils, may yield unequal percentages of nitrogen.

That the percentage of moisture in edible roots, is a constant quantity for each variety.

That beets, carrots and turnips, have a larger percentage of moisture than potatoes.

That more aliment is contained in a given weight of peas, beans or lentils, than in an equal weight of any other kind of food above analyzed.

That in several of the grains and roots analyzed, there are organic bodies beside those identical in composition with gluten and starch.

That the ashes of carrots, beets, turnips and potatoes, as Prof. v. Liebig has already remarked, contain carbonates.

That the ashes of all the varieties of vegetable food above analyzed contain iron.

Finally, that the difference between the theoretical equivalents of vegetable food, as estimated from the percentage of nitrogen, and those ascertained by the experiments of stock growers, and the differences between the results of different stock growers, may be attributed in part to the unequal percentages of nitrogen in the grains and roots of the same species or variety, when grown on different soils, — but

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chiefly to the imperfection of the modes of determining the practical equivalents. These have been imperfect,

1st. Because the prominent test employed, has been increase or diminution in weight, of the animal fed. Increase in weight may arise from secretion of fat derived from the sugar and starch of plants. Diminution in weight may follow unusual activity, increasing the consumption of fat already present.

2d. Because theoretical equivalents have been employed in conditions unequally suited to digestion. The same article of food, coarse or fine, fresh or prepared for easy digestion, yields unequal measures of nutrition.

3d. Because the experiments, in but few instances, have been made with substances where moisture and nitrogen had been previously ascertained.

AMMONIA IN GLACIERS.

By E. N. HORSFORD.

READ BEFORE THE ALBANY INSTITUTE, NEW YORK, JANUARY, 1846.

The height at which Glaciers are formed, renders their composition interesting in a meteorological point of view, commencing, as many of them do, at an elevation of more than ten thousand feet above the level of the sea. In an atmosphere of proportionally less density, it might naturally be supposed, that the moisture discharged at their sources, either as rain or snow, would differ in the nature and quantity of the substances dissolved, from that discharged at lower elevations.

Carbonate of ammonia, one of the never failing, though variable ingredients, of the atmosphere, would be less in proportion to the elevation, and less would accompany a given fall of rain or snow on the top of a high mountain, than in the bottom of a deep valley.

Glaciers are formed in localities, where, from the elevation, great excess of cold over heat, and conformation of mountain gorges, snow is permitted to accumulate. At midday in summer, the snow thaws. Later in the day it freezes; with its increase in density and mass it descends. Coming into the region of rain, the body of half snow and half ice becomes filled with water and again freezes. The constant pressure of the mass above, and the advancing movement,

unite with the alternate freezing and thawing to increase the solidity, until it is scarcely less than that of the ice covering a quiet Alpine lake.

The carbonate of ammonia that falls with the snow and rain forming the glacier, becomes, of course, enclosed in the ice. To ascertain the amount of this ingredient in the glaciers of the Savoy Alps, a little investigation was instituted, the record of which may perhaps be of service.

On September 22d, 1845, about two cubic feet of ice from the foot of the Glacier de Boisson,* were packed in cloths and salt, and transported to Geneva. Through the courtesy of Prof. Marignac, conveniences in the Geneva Academy were furnished for dissolving and evaporating what remained of the ice.

The block was carefully rinsed to remove any attached salt, and melted in a copper vessel. To prevent any loss of carbonate of ammonia, sulphuric acid was added in the progress of melting, till the water gave an acid reaction.

8.8 litres were evaporated in porcelain basins to the compass of 194 cubic centi-metres, and in a glass-stoppered flask brought to the Giessen Laboratory.

100 c.c. of the fluid were there evaporated to the compass of about 10 c.c. Upon cooling at this stage of concentration, crystals of sulphate of copper and ammonia, and gypsum, with traces of peroxide of iron, appeared. The latter two were obviously impurities of the salt in which the ice had been packed, and the copper came from the vessel in which the ice had been melted.

Bi-chloride of platinum in excess, and hydrochloric acid, were then added to throw down the ammonia. The whole was next evaporated to dryness upon a water bath, and treated with a mixture of alcohol and ether, to dissolve the excess of bi-chloride of platinum. It was then poured upon

* One of the termini of the Mers de Glace, according to Murray.

a filter, previously dried at 100° C., and weighed, and washed again with alcohol and ether till the filtrate gave no acid reaction.

After again drying at 100° C., and weighing the filter and its contents, they were burned, and in a covered crucible exposed to a dull red heat.

It was possible that a silicate of potassa, dissolved from the granite dust with which the glacier is more or less covered, might have been present. The potassa would have been thrown down with the ammonia as platin-chlorid-potassium, increasing by so much the weight of the precipitate.

By burning and heating to redness, the chlorammonium and chlorine of the bi-chloride of platinum would be expelled, while the chloride of potassium would remain undecomposed. Upon treating the residue with water, and that with nitrate of silver, no precipitate appeared. Hence there was no chlorine and no chloride of potassium present.

To remove any silica that might be present, a small quantity of pure carbonate of soda was added and fused, and the whole washed, till the wash water, evaporated upon a platinum plate, gave no residue.

The peroxide of iron was removed in washing out the carbonate of soda.

To remove the gypsum and sulphate of copper,* diluted hydrochloric acid was added and withdrawn with a pippette, till it gave with chloride of barium no precipitate.

The remainder was again dried, and weighed

0.053 grammes.

This, as pure platinum, corresponds with

0.00912 gr. of ammonia.

This obtained from 100 c.c., reckoned for 194 c.c., the

* A part of the sulphate of copper may have been reduced in heating the crucible. The whole quantity, however, was very minute, and any loss from this source was in part, if not wholly compensated by the loss of platinum in burning the filter.

contents of the flask, or 8 8 litres, the amount evaporated, or 8800 gr., the weight of the ice, gives

0.017708 gr. ammonia,

which, in per cent., equals

0.000201,

or $\frac{2}{1000.000}$ of the whole weight of the ice.

From the above notice, it is obvious,—

That ammonia is not confined to the lower strata of the air, and

That a shower of rain, after a long interval of fair weather, should produce, through the ammonia descending with it, immediate effect in vegetation ; and

That a soil, containing the necessary inorganic matters, and whose physical properties enable it to retain a certain measure of moisture, should be fruitful, inasmuch as it retains the ammonia with the moisture ; and

That a soil, containing so large a proportion of clay that it does not permit water to filter through, should be less fruitful, since the subsequent falls of rain, after the soil has become filled, will flow away, and with them the ammonia they have brought down.

ACTION AND INGREDIENTS OF MANURES.

LETTER TO PROFESSOR WEBSTER.

GIESSEN, May 1, 1846.

My dear Sir,

The discovery* to which I alluded in my last, and the important results to which it must lead, will appear in clearer light after a brief consideration of the subject of manures.

The time is not long gone by, when plants were supposed to owe their growth to some mysterious, creative power, the living principle possessed. Since the element of quantity has been carried from physics into the other departments of science, and especially into chemistry, this opinion has gradually lost its supporters. Occasionally, however, a man may still be found who demurs to a new doctrine in agricultural chemistry, with the expression — "You have not taken into proper consideration the action of the vital principle."

It is, however, well known, that without water, plants will not grow ; and that they flourish better on some soils than on others, and that the addition of manures has been instrumental in greatly augmenting the produce of fields.

What the essential ingredients of manures were, and how they act, and what are the sources of the ingredients of plants, especially of carbon and nitrogen, have been objects of repeated investigation, by some of the first scientific men of the age.

You will remember that Saussure recognized, some time since, alkalies and alkaline earths in the ashes of plants;

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* Of Ammonia in soils.

but found them in such variable proportions, that he came to the conclusion they were non-essential,—occurring in the plants merely because they were present in the soil in a soluble state.

You are aware that Bousingault has expressed the opinion, after a variety of experiments, that the value of a manure is in near relation to its percentage of ammonia.

Mulder has, you know, written much in support of the view that ulmic and humic acids, ulmates and humates, etc. in one form and another minister largely to vegetation. And in the last volume of Berzelius's Jahrs Bericht, received a day or two since, I see the above-named distinguished chemist has been recently conducting a series of experiments, lending, in his view, support to his previously expressed opinions.

Liebig differs from them all. He found that though the relative amounts of magnesia and lime, potash and soda, occurring in the ashes of a Savoy pine, and of the same species grown elsewhere, might be greatly unlike—the amount of oxygen, in combination with the metals, calcium magnesium, potassium, sodium and iron, of the ashes, was a constant quantity This observation bears the stamp of its great author, and its importance can only be estimated in connection with a detailed exposition of the evolution of organic acids, alkaloids, and indifferent bodies in the vegetable organism. Of this you will not expect me here to write. This great law he discovered and laid down, that for the full development of the organic tissues of each species, a certain percentage of inorganic bases is indispensable; and that of these, potash, to a certain amount, may replace soda, and magnesia, lime; but the *amount of oxygen must be constant.* In other words, the equivalents of base must be a constant quantity.

n When one takes in hand a ~~t~~umb~~l~~er of ash analyses of the same species of plant grown on different soils, and calculates

therefrom the percentage of oxygen of the bases, ~~one~~ he finds that the results differ but little from each other. For different species the percentages of oxygen vary, as do also the relative and absolute amounts of the several bases and acids. Liebig, as you are already aware, takes the position that the sources of carbon and nitrogen are carbonic acid and ammonia of the air, and not soluble organic bodies met with in some soils. He asks if it be not so, where the thousands of tons of wood, grown for centuries in succession on a soil containing but traces of organic matter, have derived their carbon. And again; What replaces the nitrogen shipped from Holland in hundreds of thousands of pounds of cheese yearly, if the ammonia does not come from something beside decaying organic matter?

A meadow, yielding year after year, without manure, an uniform moderate crop, by addition of gypsum had its produce increased a third.

The addition of ashes increased its production another third, and the distribution of bone ashes another third. So here, by the addition of mineral matters, its capacity of production had been doubled. No new source of carbon had been provided — no new source of ammonia — and yet the hay gathered after these additions of mineral matter, contained twice as much carbon, and at least twice as much nitrogen as before.

Where did these ingredients come from?

Bousingault's ingenious experiments with regard to the sources of carbon, had yielded a partial answer. The carbon came from the carbonic acid of the air. The ammonia, as you will presently perceive, could have had no other origin.

Faraday, I need not mention to you, found ammonia in almost all bodies. Even metals, dropped in fused potash, yielded ammonia. Sand, heated to redness, and poured upon

cooling along the back of the hand, immediately after, with potash, yielded ammonia.

Mulder has thrown out the idea, that organic bodies in the progress of decomposition, produce ammonia, not alone by parting with their nitrogen in this form, but by causing, through the molecular action attendant upon this decomposition, the union of the nitrogen of the air with the hydrogen of the organic body, or of water decomposed at the same time. Berzelius, even, says that if iron filings be placed in the bottom of a jar, they will oxydate at the expense of oxygen of water, producing, by the union of the hydrogen thus set free with the nitrogen of the air, ammonia.

Professor Will, of the Giessen Laboratory, has shown by the most conclusive experiments, in opposition to the latter most distinguished chemist, and to Mr. Reiset, who entertained a similar view, that nitrogen unites with hydrogen under no such circumstances. And Mulder's view fails in quantitative experiment of its support. Indeed, the experiments of the Dutch chemist, detailed in the last Jahrs Bericht, having a *quantitative* purpose merely, have not won the conviction of Berzelius.

Ammonia, Liebig maintains, is a body not indebted to organism for its being; that it is to be classed with iron and potash, and soda and oxygen, whose quantity, within the organism of plants and animals, and without, is in general terms constant. He holds, that when the required physical properties have been given a soil, and the necessary inorganic ingredients in suitable solubility, the ammonia and carbonic acid with healthful falls of rain will provide themselves. Muck serves so eminently well in giving the requisite porosity to a soil, that a widespread conviction prevails in America, that, somehow, it becomes dissolved, and passes, according to Mulder's view, directly into the vegetable economy, without first becoming carbonic acid, ammonia, and water.

I found ammonia in the grains which came from

The quantity, though small, was determinable by the balance, and the fact is established, that even at these elevations this ingredient does not fail.

I herewith send you the determinations of my friend Dr. Krocker, now Professor of Chemistry and Physics in the Agricultural Institute of Breslau, in Silesia.

TABLE

OF THE AMMONIA CONTAINED IN SOILS. BY DR. KROCKER.

SOILS EXAMINED.	Ammonia in 100 parts of air-dried soil.	Specific gravity.	Pounds of Ammonia in a soil of one hectare in area, and 0.25 metre deep.
Clay soil, before manuring	0.170	2.39	20314
Clay soil - -	0.163	2.42	19723
Surface soil, Hohenheim -	0.156	2.40	18720
Subsoil of the same, Hoh.	0.104	2.41	12532
Clay soil, before manuring	0.149	2.41	17953
Clay soil, " -	0.147	2.41	17713
Soil for Barley - -	0.143	2.44	17446
Clay soil, before manuring	0.139	2.41	16749
Loam - - -	0.135	2.45	16537
Loam - - - -	0.133	2.45	16292
Illinois prairie soil -	0.116	2.18	12644
Cultivated sandy soil -	0.096	2.50	12000
Excavated loam earth -	0 088	2.5	11009
Cultivated sandy soil -	0.056	2.51	7028
Nearly pure sand - -	0.031	2.61	4045
Varieties of Marl	0.0988	2.42	11952
	0.0955		11552
	0.0768		9288
	0.0736		8904
	0.0579		7004
	0.0077		931
	0.0047		568

A metre is 39.37 inches; so 0.25 metre are a little less than ten inches, or five-sixths of a foot.

A hectare contains two and a half English acres. I have converted the last column into English values, and adjoin them.

Name of Soil Examined.	Ammonia in a stratum one acre in area and one foot deep, in pounds, avoir.
Clay soil, before manuring	9751
Clay soil	9463
Surface soil, from Hohenheim	8985
Subsoil, from the same field	6015
Clay soil, before manuring	8617
Clay soil, " "	8502
Soil for Barley	8373
Clay soil, before manuring	8039
Loam	7938
Loam	7820
Illinois prairie soil	6069
Cultivated sandy soil	5760
Excavated loam earth	5280
Cultivated sandy soil	3373
Varieties of Marl	5637
	5545
	4458
	4274
	3362
	447
	272

The excavated earth was taken from a depth below the traces of organic matter. The Illinois prairie soil was brought by a returning German, in paper, from a field that had been cultivated without manuring already ten years I think.

Now, what farmer ever carted from his manure yards 8000 pounds of ammonia to an acre of land? One may almost inquire, what farmer ever carted the tenth, or even the twentieth part of this amount? It is obvious, that the ammonia spread on fields in the ordinary distribution of barn yard products, is of no moment. The quantity, with usual falls of rain, greatly exceeding in the course of a season any conceivable supply by human instrumentality. These results put the question of the source of ammonia or of nitrogen out of all doubt.

But if with the manure heap and the liquid accumulations

of the barn yard, transported to the fields, the ammonia be not the chief ingredient, or an important one, to what are we to attribute the unquestioned value of stable products and night soil?

Liebig has shown, that if plants be manured with the ashes of plants of the same species, as the grasses of our western country are when burned over in the fall, they are supplied with their natural inorganic food. He has shown the truth of the principle in a great variety of ways. Among others, he has been feeding some grape vines with the mineral matters of their ashes, in the proportions in which analyses have shown them to be present; and their development has been luxuriant in the most remarkable degree, though the soil upon which they have been grown is little better than sand. He made a variety of experiments with grains, roots, flowers, &c. which I had the pleasure of following last year, and this Spring he has commenced them upon a more extended scale.

Let us consider what these ashes are, and what manure is.

Herbivorous animals derive their nutrition from the vegetable kingdom exclusively, their food being grass, grains, roots, etc. These, with their organic and inorganic matters, are eaten. A portion of them is assimilated, becoming bone, muscle, tendon, fat, etc. Another portion is voided in the form of excrementitious matter. In process of time the bones and tissues follow the same course. What to-day forms the eye, with its sulphur and its phosphates, and carbon, &c. will have accomplished its office, and left the organism to mingle with the excrements, or escape as carbonic acid and water from the lungs. At length, all the inorganic matters will reappear in the voided products.

Carnivorous animals satiate their hunger from the already developed organism of the herbivora. Their food of course contains merely what the plants had furnished. In their excrements reappear the soluble and insoluble inorganic sub-

stances, mingled more or less, as is the case also with the herbivora, with indigestible matter, such as hair or woody fibre.

The animal organism has performed the office of a mill. Grain was supplied. Instead of appearing as flour and bran, and the intermediate meal, it appears after intervals of greater or less length, in soluble inorganic salts in the liquid excrements, in insoluble inorganic salts in the solid excrements, and in carbonic acid and water.

Now, after burning a plant, what remains? It contained, when growing,

Carbon,
Nitrogen,
Hydrogen and
Oxygen, as organic bodies, and
Water.

It contained also, in variable proportions,

Common Salt,
Potash,
Soda,
Magnesia,
Lime,
Iron,
Phosphoric acid,
Sulphuric acid and
Silica.

The first four were expelled in the combustion. The remaining ingredients for the most part remained unchanged.

Had the plant gone into the body of an animal, and in the course of its evolutions through the organism lost its carbon, hydrogen, nitrogen and oxygen, the remaining ingredients would have been the same as before.

In the one case, the plant would have been burned in the organism; in the other, in a crucible. The ashes and the excrements are the same.

The principle of rational improvement of soils is, then,

1st. *A proper physical constitution* for the retention of moisture, escape of surplus rains, expansion of roots, etc. This will be derived from the plow, harrow, spade and hoe, and admixtures of sand in some soils, clay in others, loam in others, and organic refuse in most.

2d. A supply of the inorganic ingredients which the ashes of the plant to be cultivated contains, in such a state that they may be taken readily into the vegetable system, and yet not so soluble as to be washed away by rains.

I will venture to add a single additional remark.

Seven inorganic bodies included in the ash products above mentioned, are absolutely indispensable to the growth of plants. A soil wanting these cannot yield seed capable of reproducing its kind.

Here, then, all the mysteries of gypsum being serviceable on some soils, and for a number of years, and then being no longer of use, — of its benefitting some soils greatly, and others not at all, — the great value of quick lime or of calcareous marl on some lands, and their uselessness on others,—the profit of employing bone dust generally (phosphate of magnesia and lime), — the worth in some instances of salt, — of straw, ploughed in, — of poudrette, — guano, — horn scrapings, — soda, — saltpetre, etc. — become solved.

Some soils have already sufficient sulphuric acid and lime. Gypsum would not benefit them. Others have enough of all the remaining ingredients, but lack sulphuric acid. Gypsum supplies the deficiency. Two or three years culture, or ten perhaps, exhaust another ingredient. Bone dust possibly supplies the want. In time, however, still another recur~~ring,~~ ~~is no longer present in the soil.~~ Potash or soluble silica, gypsum ~~perhaps~~ in never so large a quantity, contains no trace of phosphoric acid, or potash or silica.

A drought prevents soluble mineral matters from being

taken into the plants, and without rains the ammonia is not brought down from the air.

Night soil and guano are the ashes of animal and vegetable organism burned in animal bodies. They are the ashes of plants — essential food of plants.

Explanations of many things, hitherto obscure, present themselves to any one after contemplating this view of manures. I will not enter upon the subject of rotation of crops, whose object is chiefly the renewal of soluble mineral matters by action of the atmospheric change of temperature, etc.

I have no doubt that ere long the application of these doctrines, will reveal in the many, now considered quite exhausted farms of New England, untold sources of wealth. You would think me sanguine beyond reason if I were to express my honest conviction of the still virgin capabilities of the soil of our pilgrim fathers, and I will not venture it. We shall see.

I am, &c.

E. N. HORSFORD.

Prof. J. W. WEBSTER.